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Finishers and nonfinishers in the 'Swiss Cycling Marathon ' to qualify for the 'Race across America'

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Abstract: Knechtle, B, Knechtle, P, Rüst, CA, Rosemann, T, and Lepers, R. Finishers and nonfinishers in the 'Swiss Cycling Marathon' to qualify for the 'Race across America.' J Strength Cond Res 25(12): 3257-3263, 2011-We compared the characteristics of prerace anthropometry, previous experience, and training and support during the race in 39 finishers and 37 nonfinishers in the 'Swiss Cycling Marathon,' over 720 km. In this race, the cyclists intended to qualify for the 'Race across America,' the longest nonstop cycling race in the World from the West to the East of the USA. Finishers in the 'Swiss Cycling Marathon' had a lower body mass, a lower body mass index, lower circumferences of upper arm and thigh, a lower percent body fat, completed more weekly training units, covered more kilometers in the longest training ride, rode at a faster speed during training, rode more kilometers per week and for more hours, had more previous finishes in the 'Swiss Cycling Marathon' and a lighter race bike compared to the nonfinishers. In the bivariate analysis, the cycling distance per training unit ($r = 0.37$), the duration per training unit ($r = 0.44$), the speed per training unit ($r = -0.59$), using nutrition provided by the organizer ($r = 0.50$), and using own nutrition ($r = 0.49$) during the race were significantly and positively associated with race time. For practical applications, anthropometric characteristics such as a low body mass or low body fat were not related to race time, whereas training characteristics and nutrition during the race were associated with race time. The key to a successful finish in an ultraendurance cycling race such as the 'Swiss Cycling Marathon' seems a high speed in training and an appropriate nutrition during the race.

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Finishers and non-finishers in the ‘Swiss Cycling Marathon’ to qualify for the ‘Race across America’

Running head: Qualifying for Race across America

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ABSTRACT

We compared the characteristics of pre race anthropometry, previous experience and training as well as support during the race in 39 finishers and 37 non-finishers in the ‘Swiss Cycling Marathon’, over 720 km. In this race, the cyclists intended to qualify for the ‘Race across America’ (RAAM), the longest non-stop cycling race in the World from the West to the East of the USA. Finishers in the ‘Swiss Cycling Marathon’ had a lower body mass, a lower body mass index, lower circumferences of upper arm and thigh, a lower percent body fat, completed more weekly training units, covered more kilometres in the longest training ride, rode at a faster speed during training, rode more kilometres per week and for more hours, had more previous finishes in the ‘Swiss Cycling Marathon’ and a lighter race bike compared to the non-finishers. In the bivariate analysis, the cycling distance per training unit ($r = 0.37$), the duration per training unit ($r = 0.44$), the speed per training unit ($r = -0.59$), using nutrition provided by the organizer ($r = 0.50$) and using own nutrition ($r = 0.49$) during the race were significantly and positively associated with race time. For practical applications, anthropometric characteristics such as a low body mass or low body fat were not related to race time, whereas training characteristics and nutrition during the race were associated with race time. The key to a successful finish in an ultra-endurance cycling race such as the ‘Swiss Cycling Marathon’ seems a high speed in training as well as an appropriate nutrition during the race.

Key words: training – support – anthropometry – performance – athlete

INTRODUCTION

In recent years, several studies investigating ultra-endurance cyclists have been published. In case reports and field studies, the changes in body mass (3,14,26), the intensity and energy turnover (3,7,14,34,36,39), and the nutrition (6,12,30,31) in ultra-endurance cycling events were investigated. Others tried to find an association between anthropometry and training with race performance (18,27,29).

The most famous non-stop ultra-cycling race in the World is the 'Race Across America', called the 'RAAM'. In the 'RAAM', the cyclists have to cover about 5,000 km, with around 30,000 m of altitude, depending upon the course (12,14,30,36). To become an official finisher in the 'RAAM', the competitors have to complete the total distance within 12 days. During the whole race, the athletes must be followed by a support crew consisting of two cars providing equipment and nutrition (12,14,30,36). To enter the 'RAAM', the cyclists have to qualify in an ultra-cycling race over 720 km (444 miles), and they must finish within 115 % of the winner in order to get the qualification for a start in the 'RAAM'.

In the present study, we investigated ultra-endurance cyclists intending to qualify for the 'RAAM' by taking part in the 'Swiss Cycling Marathon'. In the 'Swiss Cycling Marathon' over 720 km with 5,580 m of altitude, non-professional athletes are competing, and they have the unique opportunity of testing their physical fitness, their equipment and their support crew in the same manner they would use in the 'RAAM'. We assumed that, apart from anthropometry, training and nutrition, other factors such as support during the race would also show an association with race performance.

The aim of the present study was to investigate the association between training, anthropometry and race support with race time in qualifiers for the 'RAAM' in a 720 km ultra-cycling race. Since 'RAAM'-qualifiers must finish within 115 % of the winner we assumed we would find associations with intensity during training, and support during the race, for a faster race time.

METHODS

Experimental Approach to the Problem

The 'Swiss Cycling Marathon' takes place every year and offers the opportunity to qualify for the 'RAAM'. In order to increase the sample size, we collected data in the 2008, 2009 and 2010 events. The organizer of the 'Swiss Cycling Marathon' contacted all the race participants via monthly newsletters, and provided information about the planned investigation. Interested athletes contacted the investigator by e-mail and were provided with the study documentation. The 'Swiss Cycling Marathon' takes place each year at the end of June/start of July. The weather conditions were comparable in all three years. In the 720 km 'RAAM'-qualifier, the cyclists must complete a 600 km loop first, and then an additional loop of 120 km. In total, they have 11 checkpoints to pass and 5,580 m of altitude to cover during the 720 km. The 600 km loop starts from the outskirts of Berne (Switzerland) over the border to Germany, then along Lake Constance into the Alps of Eastern Switzerland and back to Berne. Then, they must add the 120 km loop.

Subjects

All interested starters were included. No criteria for inclusion/exclusion were used. Any athlete intending to qualify for the 'RAAM' must finish the 'Swiss Cycling Marathon' within 115 % of the winner's time. Athletes who failed in a previous year of the 'Swiss Cycling Marathon' can start as many times as they want in future years in order to finally get the qualification to enter the 'RAAM'. A total of 76 male athletes volunteered to participate in the study, no female athlete started. The study was approved by the Institutional Review Board for use of Human Subjects of the Canton of St. Gallen, Switzerland. The athletes were informed of the experimental procedures and gave their informed written consent.

Procedures

For each year, upon entering the study via the inscription, the athletes kept a comprehensive training diary recording their training units in cycling, showing the distance (km), the duration (h) and the speed (km/h) for each training session, until the start of the race. For each year, before the start of the race body mass, body height, the length of the arm and right leg, the circumferences of limbs and the thicknesses of eight skin-folds were measured on the right side of the body. One trained investigator took all the measurements as inter-tester variability is a major source of error in anthropometric measurements. With this data, we calculated body mass index, percent body fat, skeletal muscle mass, and the sum of skin-folds using anthropometric methods. Body mass was measured using a commercial scale (Beurer BF 15, Beurer, Ulm, Germany) to the nearest 0.1 kg. Body height was measured using a stadiometer to the nearest 1.0 cm. The circumferences and lengths of limbs were measured using a non-elastic tape measure (cm) (KaWe CE, Kirchner und Welhelm, Germany). The length of the right arm was measured, from *acromion* to the tip of the third finger, to the nearest 0.1 cm on the right side; the length of the right leg from *trochanter major* to the *malleolus lateralis*, to the nearest 0.1 cm again on the right side. The circumference of the upper arm was measured in the middle of the right upper arm (between *acromion* and *olecranon*) to the nearest 0.1 cm; the circumference of the right thigh was taken at the level where the skin-fold thickness of thigh was measured (20 cm above the upper margin of the patella) and the circumference of the right calf was measured at the maximum circumference of the calf. The skin-fold data was obtained using a skin-fold calliper (GPM-Hautfaltenmessgerät, Siber & Hegner, Zurich, Switzerland) and recorded to the nearest 0.2 mm. The skin-fold measurements were taken once for all eight skin-folds (chest, mid-axilla, triceps, sub scapular, abdomen, suprailiac, front thigh and medial calf) and then the procedure was repeated twice more by the same investigator; the mean of the three times was then used for the analyses. The timing of the taking of the skin-fold measurements was standardized to ensure reliability. According to

Becque *et al.* readings were performed 4 s after applying the calliper (2). An intra-tester reliability check was conducted on 27 male athletes prior to testing. Intra-class correlation (ICC) within the two judges was excellent for all anatomical measurement sites, and various summary measurements of skin-fold thicknesses (ICC > 0.9). Agreement tended to be higher within measurers than between measurers but still reached excellent reliability (ICC > 0.9) for the summary measurements of skin-fold thicknesses (16). Percent body fat was calculated using the anthropometric formula following Ball *et al.* (1): Percent body fat = $0.465 + 0.180(\Sigma 7SF) - 0.0002406(\Sigma 7SF)^2 + 0.0661(\text{age})$, where $\Sigma 7SF$ = sum of skin-fold thickness of chest, mid-axilla, triceps, sub scapular, abdomen, suprailiac and thigh. Skeletal muscle mass was calculated using the anthropometric formula: Skeletal muscle mass = $Ht \times (0.00744 \times CAG^2 + 0.00088 \times CTG^2 + 0.00441 \times CCG^2) + 2.4 \times \text{sex} - 0.048 \times \text{age} + \text{race} + 7.8$, where Ht = height, CAG = skin-fold-corrected upper arm girth, CTG = skin-fold-corrected thigh girth, CCG = skin-fold-corrected calf girth, sex = 1 for male and 0 for female, race = 0 for white, according to Lee *et al.* (29). For each year, pre race, the weight of the race bike was determined without additional equipment. After the race, the athletes were asked whether they had completed the race alone or with the help of a support crew, whether they had followed the signposts set by the organizer or used GPS (Global Positioning System), whether they carried their own equipment to mend a flat tyre or whether they had spare parts or a complete replacement bike with them in their support car, and whether they used the nutrition provided by the organizer at the check points or whether they used their own nutrition.

Statistical Analyses

Data are presented as mean and standard deviation (SD). For finishers and non-finishers, the results of pre race anthropometry and training were compared using Kruskal-Wallis equality-of-populations rank test. Results of categorical data such as racing with or without support crew, racing using GPS, racing using a complete spare bike and racing using their own

nutrition, were compared using Fisher's exact test. Pearson correlation analysis with the independent variables of anthropometry, training and race support, and race time as the dependent variable, was performed. A probability value of less than 0.05 was accepted as significant. To achieve a power of 80% (two-sided Typ I error of 5%) to detect a minimal association between race time and anthropometric characteristics of 20% (i.e. coefficient of determination $r^2 = 0.2$) a sample of 40 participants was required. An alpha level of 0.05 was used to indicate significance.

RESULTS

Seventy-six male subjects entered the investigation, 39 cyclists (51%) finished the ‘Swiss Cycling Marathon’ within the time limit. The ‘RAAM’-qualifiers completed the 720 km within 26.6 (2.5) h and 27.4 (15.5) min, cycling at 26.8 (2.2) km/h. Race time was also expressed as a percentage of the course record (22:24 h:min for the 720 km); the athletes finished within 120 (11) % of the course record. Among the 37 unsuccessful ‘RAAM’-qualifiers, the athletes complained about exhaustion (9 athletes), loss of orientation (6 athletes), problems with the locomotor system (4 athletes), tiredness (4 athletes), too much traffic (4 athletes), arriving after closure of the race (3 athletes), problems with digestion (2 athletes), loss of motivation (3 athletes), and technical problems with the bike (2 athletes).

The finishers had a lower body mass, a lower body mass index, a lower circumference of upper arm and thigh, and a lower percent body fat compared to the non-finishers (see **Table 1**). None of the anthropometric characteristics was related to race time in the finishers.

Considering previous experience, training and race bike, the finishers completed more weekly training units, covered more kilometres in the longest training ride, rode at a faster speed during training, rode more kilometres per week and for more hours, had more finishes previously in the ‘Swiss Cycling Marathon’ and had a lighter race bike compared to the non-finishers (see **Table 2**). Distance (see **Figure 1**), duration (see **Figure 2**) and speed (see **Figure 3**) per training unit were associated with race time. Distance ($r = -0.47$, $p = 0.0030$) and duration ($r = -0.55$, $p = 0.0005$) per training unit were significantly and negatively related to speed during training. No differences were found between finishers and non-finishers regarding support and nutrition during the race (see **Table 3**). Racing using their own nutrition ($r = 0.50$) and racing using nutrition provided by the organizer ($r = 0.49$) were both related to race time in finishers.

DISCUSSION

The aim of this study was to investigate the association of anthropometry, training and race support with race time in male athletes in the ‘Swiss Cycling Marathon’, a qualifier for the ‘RAAM’. Since ‘RAAM’-qualifiers must finish within 115 % of the winner, we assumed that we would find associations with intensity during training and support during the race, in order to ride a faster race. The main finding was that training variables such as distance, duration and speed per training unit as well as nutrition during the race were associated with race time after multivariate analysis.

Since 49 % of the participants were not able to finish the 720 km within the time limit, we thought we might find important differences between finishers and non-finishers. Regarding anthropometry, the finishers had a lower body mass, a lower body mass index, a lower circumference of upper arm and thigh and lower percent body fat than the non-finishers. Respecting existing literature, we would expect that anthropometric variables such as body mass (15), body mass index (9,13), circumference of upper arm (15,17), body fat (10,23,25), or skin-fold thicknesses (19,22) would be related to race time. Regarding especially cyclists, one might assume that body mass (37,38) would also be related to race time in ultra-endurance cyclists. However, anthropometric variables showed no association with race time in these ultra-endurance athletes as has already been found in ultra-triathletes (20), ultra-cyclists (18,29), and ultra-runners in both a single stage ultra-marathon (24) and a multi-stage ultra-marathon (21). Presumably, ultra-endurance athletes seem not to profit from specific anthropometric characteristics for a fast race time.

Considering training, the finishers completed more weekly training units, covered more kilometres in the longest training ride, rode at a faster speed during training and rode more

kilometres per week and for more hours. The cycling distance per training unit, the duration per training unit and the speed per training unit were associated with race time in the bivariate analysis. This finding is in line with previous findings of training in cyclists where long-term training programmes seem to be of importance for cycling performance (35). Literature regarding the association between training and race performance in ultra-endurance athletes is, however, rather scarce (11,20,23,24). In long-distance triathletes, training distances seem to be more important than training paces in the preparation for an Ironman triathlon (8,32). Obviously, training seems to be of higher importance than particular anthropometric characteristics for ultra-endurance cyclists.

When we examine the training variables in details, we see that speed in cycling during training was the single variable that was both different between non-finishers and finishers and related to race time in the finishers. Variables of training volume such as maximal cycling distance per training unit, mean weekly distance in cycling and mean weekly duration of training were different between non-finishers and finishers but not related to race time for finishers. Distance and duration per training unit were significantly and positively associated with race time in finishers where finishers training fewer kilometres per unit and lesser minutes per unit were riding faster in the race. This supports the finding that speed during training was significantly and negatively related to race time and that both distance and duration per training unit were significantly and negatively related to speed during training. Therefore, neither large training volumes in kilometres nor long training rides seem to be related to performance in these ultra-endurance cyclists but rather short training units at high intensity although the successful finishers were investing more kilometres and more hours in the training than the non-finishers. We would therefore assume that intensity in training seems more important than volume in these ultra-endurance cyclists. This presumption might also be supported by the finding that the coefficient of correlation for mean speed in per training unit

was higher ($r = -0.59$) than the coefficients for distance ($r = 0.37$) and duration ($r = 0.44$) per training unit, respectively. Likewise, in other ultra-distance athletes such as ultra-runners (21), Ironman triathletes (27) and ultra-swimmers (13), speed during training was associated with race performance.

A further hypothesis was that support during the race would be related to race time. During the 'Swiss Cycling Marathon' the riders own support crew can supply equipment, or a complete bike, in case of technical problems. In the 'RAAM', riders must have a support crew with two cars. Considering equipment and nutrition, the finishers rode a lighter race bike compared to the non-finishers; however, the weight of the race bike was not related to race time. During such as a race, athletes change their clothing and may put drinking bottles with different weight in their bottle cages. Accordingly, the weight of the race bike will change during the race. Adequate nutrition is important for ultra-endurance performance (4,5,33). We found no differences for nutrition between finishers and non-finishers. In the bivariate analysis, however, racing using their own nutrition and racing using nutrition provided by the organizer were both related to race time in finishers. The finding that both using own nutrition and using the provided nutrition were associated with race time might be due to the fact that several athletes used both their own nutrition and nutrition provided by the organizer. Of the 39 finishers, 14 athletes indicated to have used nutrition provided by the organizer and 31 athletes relied on their own nutrition. Six athletes used both the nutrition provided by the organizer and their own nutrition. This was obviously the reason for this finding.

Limitations of the present study and implications for future research directions

This study is limited that the subjects finished within 120% of the course record. The findings therefore do not apply to cyclists who finished faster or slower than 120% of the course record. A further limitation of this investigation is the fact that we did not determine energy

turnover (3,7,14), change in body composition (3,14) and energy intake (31,34), since an energy deficit may limit ultra-endurance performance.

PRACTICAL APPLICATIONS

It is noteworthy that ~50% of the starters were not able to finish the 720 km of the 'Swiss Cycling Marathon' within the time limit and so could not qualify for the 'RAAM'. Although successful finishers had a lower body mass, a lower body mass index, a lower circumference of upper arm and thigh and a lower percent body fat compared to non-finishers, anthropometric characteristics showed no association with race time in the finishers. In the bivariate analysis, training variables such as cycling distance per training unit, duration per training unit and speed per training unit as well as nutrition during the race were associated with race time. For practical applications, anthropometric characteristics such as a low body mass or low body fat were not related to race time, whereas training characteristics such as high intensity and nutrition during the race were associated with race time. The key to a successful finish in an ultra-endurance cycling race such as the 'Swiss Cycling Marathon' seems a high speed in training as well as an appropriate nutrition during the race.

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	Non-Finisher (<i>n</i> = 37)	Finisher (<i>n</i> = 39)	<i>r</i>
Age (y)	44.3 (8.1)	41.3 (6.9)	0.22
Body height (cm)	179 (7)	179 (5)	0.21
Body mass (kg)	81.1 (8.6)	75.4 (7.4) *	0.18
Body mass index (kg/m ²)	25.1 (2.5)	23.4 (1.5) **	0.09
Length of leg (cm)	87.4 (5.5)	88.4 (3.4)	0.00
Length of arm (cm)	81.7 (5.1)	82.0 (3.6)	0.06
Circumference of upper arm (cm)	30.8 (1.8)	29.7 (1.9) *	0.05
Circumference of thigh (cm)	57.6 (2.9)	56.1 (2.7) *	- 0.06
Circumference of calf (cm)	38.6 (2.5)	38.4 (2.1)	0.08
Percent body fat (%)	16.8 (4.5)	13.3 (3.4) **	0.22
Skeletal muscle mass (kg)	40.6 (3.5)	40.4 (3.3)	0.07

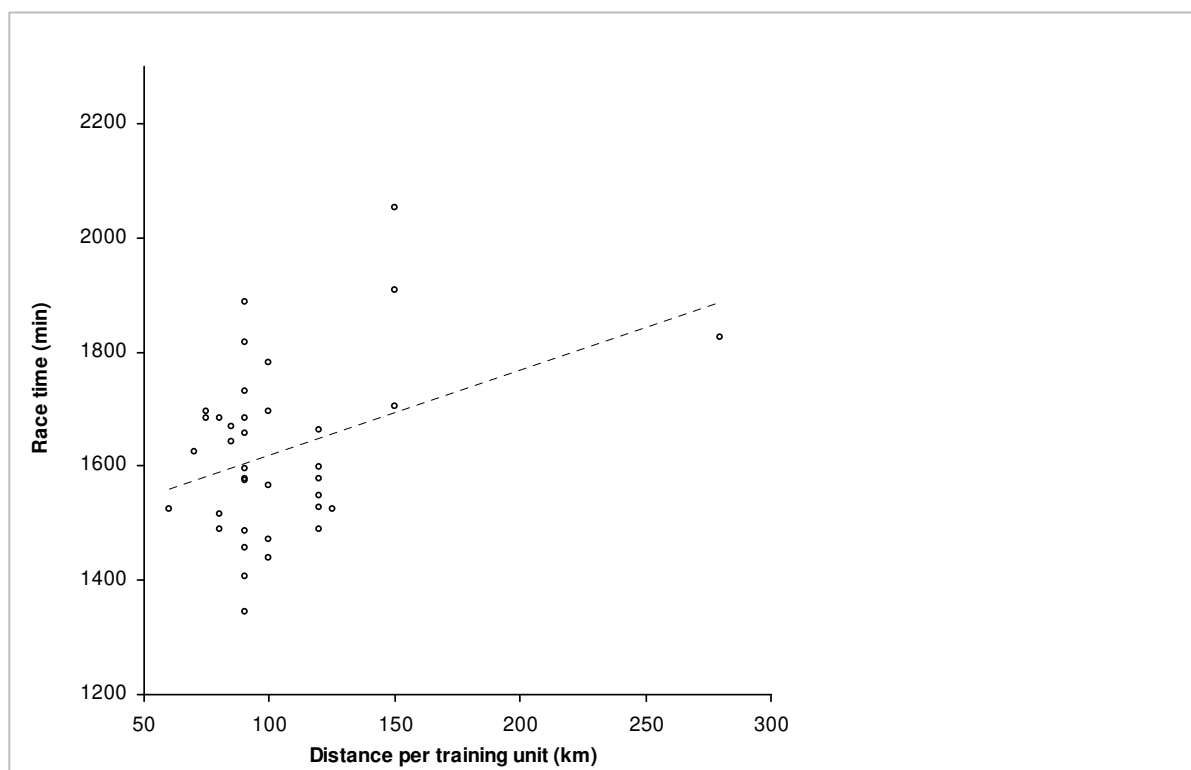
Table 1: Comparison of anthropometric variables between non-finishers and finishers and association with race time for finishers. Results are given as mean and standard deviation. * = $p < 0.05$, ** = $p < 0.01$. For finishers, no relationship of anthropometric characteristics with race time was found.

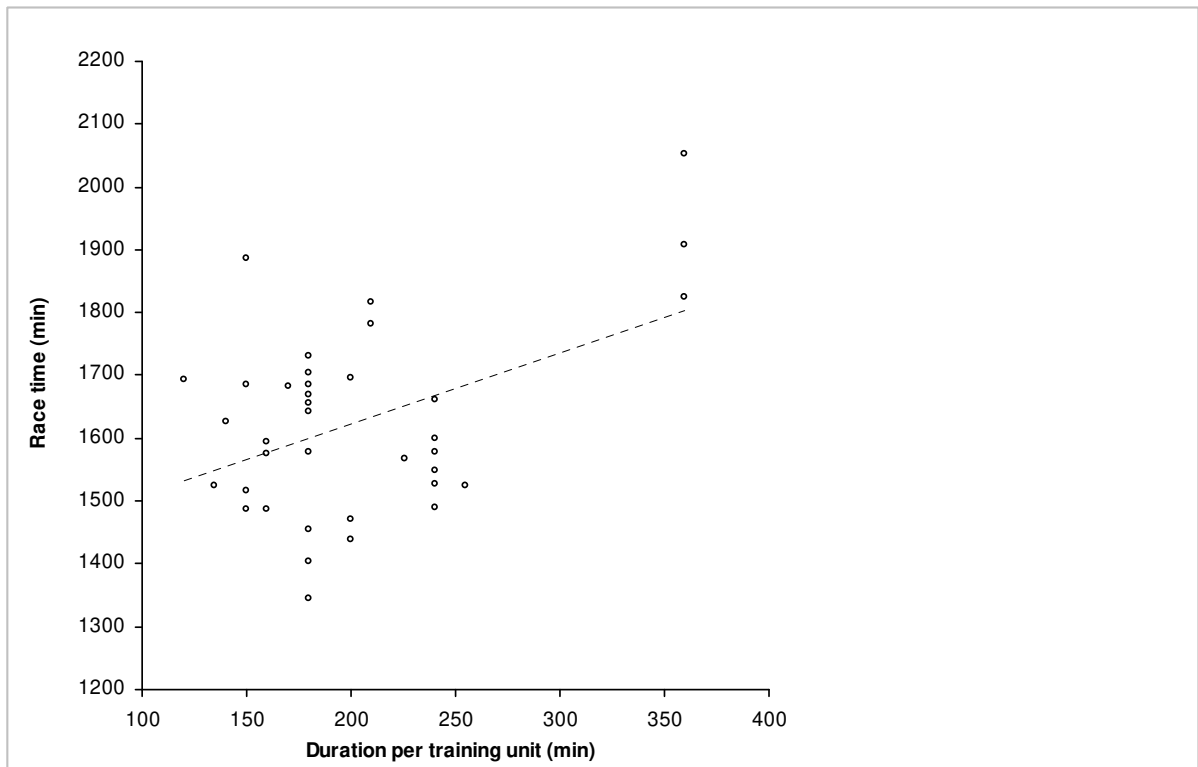
	Non-Finisher (n = 37)	Finisher (n = 39)	r
Years as active cyclist	12.9 (8.5)	10.4 (5.8)	0.01
Kilometres covered in the year before race	12,232 (9,289)	13,110 (6,742)	- 0.27
Number of training units in cycling per week	3.8 (1.7)	4.6 (2.9) *	- 0.25
Minimal cycling distance per training unit (km)	54.5 (29.5)	47.0 (20.5)	0.04
Maximal cycling distance per training unit (km)	229.5 (86.3)	297.1 (108.4) **	0.05
Cycling distance per training unit (km)	92.9 (35.3)	103.9 (36.9)	0.37, $p = 0.0261$
Duration per training unit (min)	200.5 (87.4)	201.8 (58.7)	0.44, $p = 0.0060$
Speed per training unit (km/h)	27.8 (1.8)	29.2 (2.0) **	- 0.59, $p = 0.0001$
Weekly distance in cycling (km)	342.2 (215.7)	441.8 (160.5) *	- 0.05
Weekly duration of training (h)	12.3 (8.5)	14.7 (4.9) *	- 0.12
Number of finished 'Swiss Cycling Marathons'	0.3 (0.7)	1.8 (1.7) **	- 0.12
Weight of the race bike (kg)	8.7 (1.5)	7.8 (0.8) *	0.26

Table 2: Comparison of variables of training and pre race experience in finishers and non-finishers. Results are given as mean and standard deviation. P-values are inserted in case of a significant association. * = $p < 0.05$, ** = $p < 0.01$.

	Non-Finisher (<i>n</i> = 37)	Finisher (<i>n</i> = 39)	r
Racing alone	21	9	0.20
Racing with support crew	16	30	- 0.20
Racing following signpost set by organizer	31	22	- 0.04
Racing following GPS	6	17	- 0.10
Racing with tubes and pump	23	11	0.11
Racing with complete spare bike	14	27	- 0.13
Racing using nutrition provided by organizer	20	14	0.50, <i>p</i> = 0.0021
Racing using own nutrition	21	31	0.49, <i>p</i> = 0.0020

Table 3: Comparison of equipment and support during the race between finishers and non-finishers. Some athletes used both GPS and signposts, support crew or rode during the day alone, or used own their nutrition and nutrition provided by the organizer. For finishers, racing using nutrition provided by the organizer and using own nutrition were associated with race time. P-values are inserted in case of a significant association.





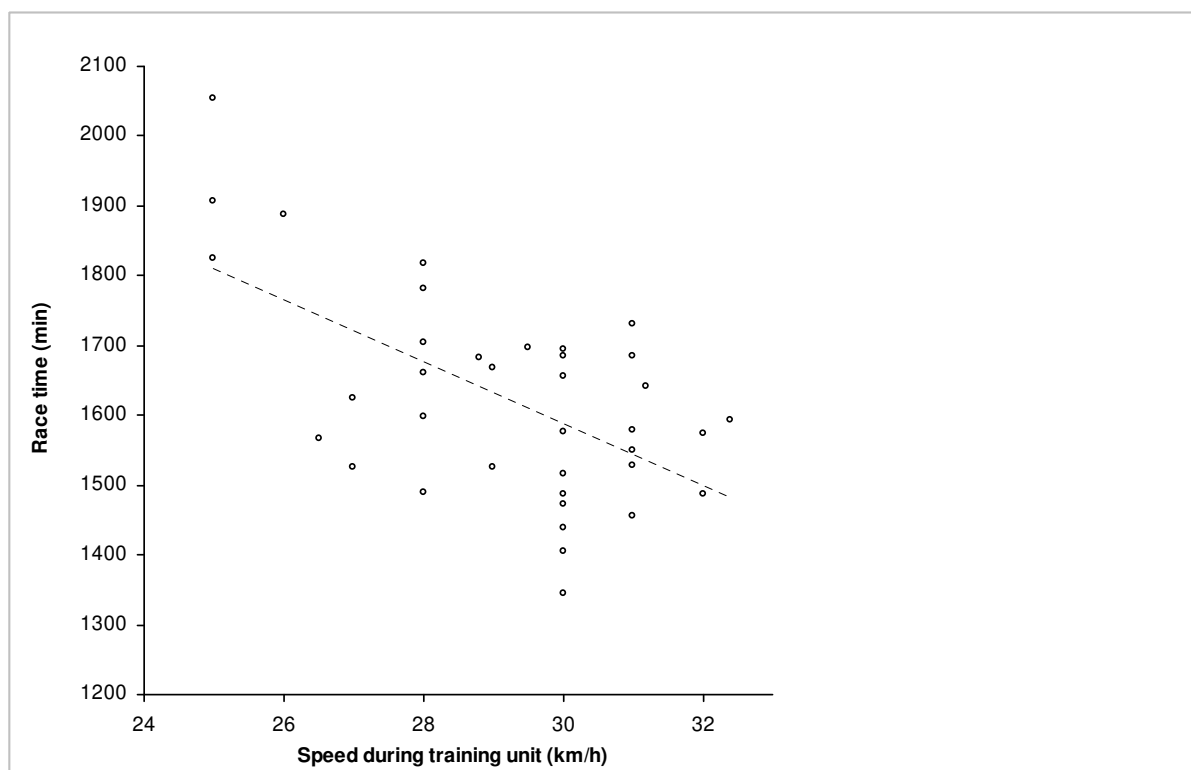


Figure 3: The cycling speed during the training units was significantly and negatively related to race time ($n = 39$) ($r = -0.59$, $p = 0.0001$).